

This is an nVent RAYCHEM specification. A qualified design professional should review and edit the document to suit project requirements.

For more information, contact RAYCHEM, a brand of nVent, 899 Broadway St., Redwood City, CA 94025-1146; Phone: 800-545-6258; Website: www.nvent.com/RAYCHEM

SECTION 238313 - RADIANT-HEATING ELECTRIC CABLES FOR SURFACE SNOW MELTING – MI

or

SECTION 321743 – PAVEMENT SNOW MELTING SYSTEMS FOR SURFACE SNOW MELTING – MI

Revise this Section by deleting and inserting text to meet Project-specific requirements.

This Section uses the term "Architect." Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes electric heating cables for surface snow melting with the following electric heating cables:
 - 1. Surface Snow Melting: Mineral insulated, series resistance.
- B. Related Requirements:

Retain subparagraphs below to cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections.

- 1. Section 210533 "Heat Tracing for Fire-Suppression Piping."
- 2. Section 220533 "Heat Tracing for Plumbing Piping."
- 3. Section 230533 "Heat Tracing for HVAC Piping."
- 4. Section 238323 "Radiant-Heating Electric Panels."
- 5. Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

6. Section 260526 "Grounding and Bonding for Electrical Systems."

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include the following:
 - a. Heating product data sheet.
 - b. UL-listed certificates for heating product.
 - c. System installation and operation manual.
 - d. System installation details.
 - e. Connection kits and accessories data sheet.
 - f. Controller/thermostat data sheet.
 - g. Controller/thermostat wiring diagram.
 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
 3. Schedule heating capacity, length of cable, and electrical power requirement for each electric heating cable required.
 4. Include design calculations for each application.
- B. Shop Drawings: For electric heating cable.
 1. Include plans, sections, and attachment details.
 2. Include diagrams for power, signal, and control wiring.
 3. Manufacturer to produce detailed design as described below.

RAYCHEM offers detailed design services. For information contact local representative, visit www.nvent.com/RAYCHEM, or contact RAYCHEM Technical Support at (800) 545-6258.

With this service, RAYCHEM provides: Circuit Layout Drawings, Isometric Drawings, Detail Drawings, Control Panel Drawings, System Wiring Diagram, and Controller Set-Point Schedule.

"Delegated Design Submittal" Paragraph below is defined in Section 013300 "Submittal Procedures" as a "Delegated Design Submittal." Retain below if design services have been delegated to Contractor.

- C. Delegated Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Delegated design submittals include the following:

Retain "Surface Snow-Melting Layout Drawings" and "Surface Snow-Melting Installation Detail Drawings" subparagraphs below for surface snow melting applications.

1. Surface Snow Melting Layout Drawings: Drawings to be provided, including the following:
 - a. Location/identification of area to be traced.
 - b. Area dimensions.
 - c. Expansion joints, crack control, and trench locations.
 - d. Heater circuit number.
 - e. Watt density.
 - f. Electrical load.
 - g. Heater catalog number.

- h. Heater termination points.
 - i. Startup temperature.
 - j. Pavement profile details.
 - k. Location of all components
 - l. Material list of all components and quantities used.
 - m. Heating cable layout.
2. Surface Snow-Melting Installation Detail Drawings: Project-specific Detail Drawings, including details showing the following:
- a. Expansion joints.
 - b. Crack control joints.
 - c. Trenches.
 - d. Junction boxes.
 - e. Pavement.
 - f. Sensor.

Retain "Control Panel Drawings," "System Wiring Diagram," and "Controller Set-Point Schedule" subparagraphs below for all applications.

- 3. Control Panel Drawings: Drawings for each control panel to include the following:
 - a. Physical arrangement and structural Detail Drawings.
 - b. Complete power and control wiring diagrams showing all internal wiring connections for electrical and instrument components in each control panel. All wires, terminals, and devices are numbered and tagged in accordance with system elementary diagrams.
 - 4. System Wiring Diagram: Project-specific Drawings (if applicable) including the following:
 - a. Interconnect of all major components.
 - b. Assignment of circuiting.
 - c. Connection of circuit wiring in terminal blocks.
 - d. Connection of sensor wiring.
 - e. Connection of external alarm wiring.
 - 5. Controller Set-Point Schedule (If applicable) showing the following:
 - a. Circuit addresses.
 - b. Circuit set points.
 - c. Circuit alarms and settings.
 - 6. Power Distribution Panel Board Schedules (If applicable) showing the following:
 - a. Heat tracing circuit allocation.
 - b. Breaker size.
 - c. Voltage and wattage.
 - d. Operating load amperes.
- D. Testing Instructions and Reporting Form: Provide documentation for use in preinstallation testing of heat tracing system.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.
- B. Testing: Completed system test report.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. ISO-9001 registered.
 - 2. Provide products consistent with UL 515 and/or UL 1683, UL 1588, CSA 22.2 No 130, and IEEE 515.1 requirements.
- B. Installer Qualifications:
 - 1. System Installer to have complete understanding of product and product literature from manufacturer or authorized representative prior to installation.
 - 2. Electrical connections to be performed by licensed electrician.
- C. Certification: System (Heating Cable, Connection Kits, and Controller): UL-listed, CSA-certified surface snow melting systems.
- D. Testing: Heating cable for surface snow melting systems to be qualified and tested to demonstrate a useful lifetime in excess of 20 years.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in original, unopened containers or packages with intact and legible manufacturers' labels identifying the following:
 - 1. Product and /manufacturer.
 - 2. Length/quantity.
 - 3. Lot number.
 - 4. Installation and operation manual.
 - 5. Material safety data sheet (MSDS) (if applicable).
- B. Store heating cable in clean, dry location with a temperature range of 0 to 140 deg F (-18 to 60 deg C).
- C. Protect heating cable or heating mats from mechanical damage.
- D. Protect heating cable ends from moisture ingress until final termination of heating cable is complete.

1.8 WARRANTY

When warranties are required, verify with Owner's counsel that warranties stated in this article are not less than remedies available to Owner under prevailing local laws.

For more detailed information on RAYCHEM's Limited Product Warranty, see www.nvent.com/RAYCHEM.

Retain first "Manufacturer's Limited Warranty" and "Manufacturer's Extended Warranty" paragraphs below for surface snow-melting applications.

- A. Manufacturer's Limited Warranty: Manufacturer agrees to repair or replace electric heating products listed below that fail in materials or workmanship within specified warranty period, when such goods are properly installed, operated, and maintained in accordance with product documents.
 - 1. Covered products include the following:
 - a. Heating cables, connection kits, and accessories.
 - b. Thermostats, controllers, panels, contactors, sensors, and accessories.

Verify available warranties and warranty periods for electric heating cable and retain "Warranty Period for Heating Cable" Subparagraph below as required.

- 2. Warranty Period for Heating Cable: Two years from date of Substantial Completion.

As a demonstration of quality, RAYCHEM offers an extended warranty on all heating cable and components manufactured. The extended warranty is free to the Owner. Contractor (or RAYCHEM field technician) must perform a system test as outlined in RAYCHEM's installation manual. Although some manufacturers do not offer an extended warranty due to variations in product quality, they may make an exception on certain projects to meet specification. Hence, require that the extended warranty being offered is published on manufacturer's website.

- B. Manufacturer's Extended Warranty: Provide Owner an extended product warranty for heat tracing products described below.
 - 1. Contractor must complete and forward to Owner the Installation, Inspection, or Commissioning Record(s), and complete manufacturer's online warranty registration form within 30 days from date of installation; otherwise, only standard limited warranty applies.
 - 2. Warranty Period for Heating Cable: 10 years from date of Substantial Completion.
 - 3. Heating cables, panels, and components not automatically offered with an extended manufacturer's warranty, as a standard matter of course, will not be allowed.
 - 4. Warranty information must be published on manufacturer's website.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR ELECTRIC HEATING CABLES

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Source Limitations: All system components to be sourced from a single manufacturer, under no circumstances are any components installed other than those supplied by cable manufacturer, to ensure system integrity and to meet warranty requirements.

2.2 MINERAL-INSULATED, SERIES-RESISTANCE HEATING CABLES

Retain this article for snow melting on pavement.

Retain "Basis-of-Design Product" Paragraph and list of manufacturers below to require a specific product or a comparable product from manufacturers listed.

- A. Basis-of-Design Product: Subject to compliance with requirements, provide RAYCHEM; a brand of nVent; MI - Surface Snow Melt or comparable product by one of the following:
 1. <Insert manufacturer's name>.
- B. System Description: Complete system for snow melting of concrete, asphalt, and under pavers. System consists of mineral insulated heating cable, accessories, and temperature and moisture sensing control; monitoring; integrated ground-fault circuit protection; and BMS communication capabilities.
 1. System spacing requirements based on supply voltage, application, and location. Generally, the required watt density for a snow melting application in the Northeast US will be 35 to 45 W per square foot (square meter). This system will operate on voltages 120 to 600 V.
- C. Compliance: UL 515, CSA 22.2 No 130-16, and IEEE 515.1.
- D. Heating Element: Single-conductor resistor wire terminated with waterproof, factory-assembled, nonheating leads with connectors at both ends.
- E. Electrical Insulating Mineral: Magnesium oxide.
- F. Jacket: Extruded low-smoke zero halogen (LSZH) jacket to protect cable from corrosive elements that can exist in concrete.
 1. Identification: Heating cable is supplied with an identification tag that contains the heating cable catalog number, length, power output, operating voltage, agency listings, serial number, and temperature code.
- G. Heating cable core materials are inorganic and do not deteriorate with age.
- H. Heating cables are factory-fabricated to the length required and are not be altered at site. Heated-section is joined to cold-lead section with factory-made joint. Cold-lead length is ordered in accordance with site requirements.
- I. Heating cables are selected to deliver sufficient heat to melt snow under regional or site-specific conditions (see construction documentation) and circuit zoning complies with construction documentation.
- J. Voltage: [120] [208] [240] [277] [347] [480] [600] V without use of transformers.
- K. Maximum Operating Temperature: [300 deg F (150 deg C)] <Insert temperature>.
- L. Heating cable to be part of a UL-listed and CSA-certified system.
- M. Accessories:

Retain first option in "Fasteners" Subparagraph below for single-pour concrete installations. Retain second option for slab constructions where topping is applied over cables on a set surface (e.g., two-pour concrete slabs or stairs, road asphalt, or mastic asphalt).

1. Fasteners: [Fasten cable to reinforcing steel mesh at prescribed spacing, using nylon (or other nonmetallic) tie-wraps.] [Fasten cables at prescribed spacing, using pre-punched galvanized-steel strapping, RAYCHEM; HARD-SPACER-GALV-25MM-25M.]
2. Snow-Melt Caution Sign. As required by national electrical codes to indicate that an electrical snow melting system is installed in slab.

Retain "Basis-of-Design Product" Subparagraph below to require a specific product.

- a. Basis-of-Design Product: RAYCHEM; SMCS.

N. Controls:

Retain "Single-Circuit Local Digital Control System"; "Multi-Circuit, Group Control System - Single Phase"; "Multi-Circuit, Group Control System - Three Phase"; or "Multi-Circuit, Distributed Digital Control System" Subparagraph below:

1. Single Circuit Local Digital Control System:
 - a. Single circuit snow/ice melting controller:

Retain "Basis-of-Design Product" Subparagraph below to require a specific product.

- 1) Basis-of Design Product: RAYCHEM; [APS-3C] [APS-4C].

Retain first two subparagraphs below if selecting RAYCHEM's "APS-4C" controller.

- b. Heating cable manufacturer provides a single-circuit snow/ice melting controller with built-in GFPD compatible with selected heating cable.
- c. Electronic snow/ice melting controller has a GFPD with adjustable trip levels of 30, 60, and 120 mA.

Retain first option in first subparagraph below if specifying RAYCHEM's "APS-3C" controller; second option for "APS-4C" 277 V controller; third option for "APS-4C" 208 V or 240 V controller.

- d. Electronic snow/ice melting controller has [24 A] [40 A] [50 A] switching capacity rating.

Retain first option in "Controller Supply Voltage" Subparagraph below for RAYCHEM's "APS-3C" controller; second option for "APS-4C" controller.

- e. Controller Supply Voltage: Electronic snow/ice melting controller is capable of operating with supply voltages of [120 V, and 208 to 240 V] [208 to 240 V, and 277 V].
- f. Electronic snow/ice melting controller is capable of supporting up to six aerial and/or slab-mounted temperature and moisture sensors.

Retain "Basis-of-Design Product" Subparagraph below to require a specific product.

- 1) Basis-of-Design Products: RAYCHEM; [Type Snow Owl aerial] [and] [Type SIT-6E slab-mounted].
- g. Enclosure type to be NEMA 3R polycarbonate.
- h. Electronic snow/ice melting controller has an adjustable hold-on timer (zero to 10 hours).
- i. Electronic snow/ice melting controller has an integrated high-limit temperature sensor.
- j. Electronic snow/ice melting controller has contacts (10 mA dry switch contact) to interface with EMC.
- k. Inputs: Override On, Override Off
- l. Outputs: Supply, Snow, Heat, High Temp, Alarm
- m. Digital controller has c-UL-us approvals.
2. Multi-Circuit, Group Control System - Single Phase:
 - a. Group controller to be snow melting and de-icing power distribution and control panel.

Retain "Basis-of-Design Product" Subparagraph below to require a specific product.

- 1) Basis-of-Design Product: RAYCHEM; SMPG1.
- b. Heating cable manufacturer provides a group snow/ice melting controller with built-in GFPD compatible with selected heating cable.
- c. Group snow/ice melting controller has an integrated 30 mA ground-fault circuit breaker.

Custom SMPG panel designs are available if standard configurations are unsuitable. Contact RAYCHEM sales representative for more information and pricing.

- d. Group snow/ice melting controller has [6] [12] [18] ground-fault circuit breakers rated up to 50 A.

Retain first subparagraph below if applicable.

- e. Group snow/ice melting controller has a main circuit breaker.
- f. Group snow/ice melting controller is capable of operating with supply voltages of [208 V] [277 V].
- g. Group snow/ice melting controller is capable of supporting up to six aerial or gutter mounted temperature/moisture sensors.
- h. Group snow/ice melting controller enclosure to be [NEMA 1/12] [NEMA 3R/4].
- i. Group snow/ice melting controller has an adjustable hold-on timer (zero to 10 hours).
- j. Group snow/ice melting controller has an integrated high-limit temperature sensor.
- k. Electronic snow/ice melting controller has contacts to interface with EMC.
 - 1) Inputs: Override On, Override Off.
 - 2) Outputs: Supply, Snow, Heat, High Temp, Alarm.
- l. Digital controller has c-UL-us approvals.
3. Multi-Circuit, Group Control System - Three Phase:
 - a. Group controller to be snow melting and de-icing power distribution and control panel.

Retain "Basis-of-Design Product" Subparagraph below to require a specific product.

- 1) Basis-of-Design Product: RAYCHEM; SMPG3.
- b. Heating cable manufacturer provides a group snow/ice melting controller with built-in GFPD compatible with selected heating cable.
- c. Group snow/ice melting controller has an integrated 30 mA ground-fault circuit breaker.

Custom SMPG panel designs are available if standard configurations are unsuitable. Contact RAYCHEM sales representative for more information and pricing.

- d. Group snow/ice melting controller has **[one]** **[two]** **[three]** 3-pole shunt trip circuit breakers with external ground-fault sensors.

Retain first subparagraph below if applicable.

- e. Group snow/ice melting controller has a main circuit breaker.
- f. Group snow/ice melting controller is capable of operating with 3-phase supply voltage **[208 V]** **[480 V]** **[600 V]**.
- g. Group snow/ice melting controller is capable of supporting up to six aerial or gutter-mounted temperature/moisture sensors.
- h. Group snow/ice melting controller enclosure to be **[NEMA 1/12]** **[NEMA 3R/4]**.
- i. Group snow/ice melting controller has an adjustable hold-on timer (0 to 10 hours).
- j. Group snow/ice melting controller has an integrated high-limit temperature sensor.
- k. Electronic snow/ice melting controller has contacts to interface with EMC.
 - 1) Inputs: Override On, Override Off.
 - 2) Outputs: Supply, Snow, Heat, High Temp, Alarm.
- l. Digital controller has c-UL-us approvals.
- 4. Multi-Circuit, Distributed Digital Control System.
 - a. Surface snow-melting circuits to be controlled and monitored using a digital control system.

Retain "Basis-of-Design Product" Subparagraph below to require a specific product.

- 1) Basis-of-Design Product: RAYCHEM; ACS-30.
- b. Multi-application: Distributed digital control system has preprogrammed parameters to provide concurrent control for heating cables used for pipe freeze protection, flow maintenance, hot-water temperature maintenance, surface snow melting, roof and gutter de-icing, freezer frost heave prevention, and floor-heating applications.
- c. User Interface Terminal: For all programming

Retain "Basis-of-Design Product" Subparagraph below to require a specific product.

- 1) Basis-of Design Product: RAYCHEM; ACS-UIT3.
- 2) Certification: c-CSA-us Certified.
- 3) Terminal Display: Color LCD display with password protection to prevent unauthorized system access.
- 4) Capable of communicating with up to 52 power control panels, where each panel can control up to five circuits and accept up to five temperature inputs.
- 5) Digital control system shall be capable of assigning up to four temperature inputs per heat-tracing circuit.

- 6) Capable of communicating with up to 16 remote monitoring modules, where each module can accept up to eight temperature inputs.
- 7) USB port to allow for quick and easy software update.
- 8) Programmable Alarm Contacts: Three, including an alarm light on enclosure cover.
- 9) Provide separate offline software tool to allow users to preprogram digital control system and transfer program via USB drive or Ethernet.
- 10) Enclosure: NEMA 4 for indoor or outdoor locations.
- d. Power Control Panels:

Retain "Basis-of-Design Product" Subparagraph below to require a specific product.

- 1) Basis-of-Design Products: RAYCHEM; ACS-PCM2-5.
- 2) Certification: c-UL-us Listed.
- 3) Enclosure: NEMA 4/12 enclosure approved for nonhazardous indoor and outdoor locations.
- 4) Provide ground-fault and line current sensing alarming, switching and temperature inputs for five heat-tracing circuits.
- 5) Contactors: Five 3-pole, 30A contactors, EMR type.
- 6) Capable of operating at 120 to 277 V.
- 7) Alarm contact, including alarm light on panel cover.
- e. Controllers may be added to the control system for single-circuit extensions.

Retain "Basis-of-Design Product" Subparagraph below to require a specific product.

- 1) Basis-of-Design Product: RAYCHEM; C910-485.
- f. Temperature Inputs: Digital control system is capable of assigning up to four temperature inputs per heat-tracing circuit.

Retain "Basis-of-Design Product" Subparagraph below to require a specific product.

- 1) Basis-of-Design Product: RAYCHEM; RTD.
- g. Remote Monitoring Modules: User Interface Terminal is capable of communicating with up to 16 remote monitoring modules, where each module is capable of accepting up to eight temperature inputs.

Retain "Basis-of-Design Product" Subparagraph below to require a specific product.

- 1) Basis-of-Design Product: RAYCHEM; RMM2.
- h. User Interface Terminal has the following:
 - 1) USB port to allow for quick and easy software updates.
 - 2) Three programmable alarm contacts, including an alarm light on enclosure cover.
- i. Provide separate offline software tool to allow users to pre-program digital control system and transfer program via USB drive or Ethernet.
- j. User Interface Terminal Enclosure: NEMA 4 for indoor or outdoor locations.
- k. Power Control Panel Enclosures: NEMA 4/12 enclosure approved for nonhazardous indoor and outdoor locations.
- l. Power control panel provides ground-fault and line current sensing alarming, switching, and temperature inputs for five heat tracing circuits.
- m. Each power control panel has five 3-pole, 30 A contactors (EMR type).

- n. Digital Controller:
 - 1) Integrated adjustable GFPD (10 to 200 mA).
 - 2) Capable of being configured for On/Off, ambient sensing, PASC, and timed duty cycle control modes based on application. PASC control proportionally energizes power to heating cable to minimize energy based on ambient sensed conditions.
 - 3) Upon communication loss with user interface terminal, panels shall control with last downloaded set point.
 - 4) Include built-in self-test feature to verify proper functionality of heating cable system.

If selecting BACnet or Metasys protocol in first subparagraph below, include RAYCHEM ProtoNode RER multi-protocol gateway as an accessory.

- 5) BMS Communication Protocol: By [Modbus] [BACnet or Metasys N2].
- 6) Variables monitored by digital controller and reported back to BMS include:
 - a) Temperature.
 - b) Ground-fault.
 - c) Current draw.
 - d) Power consumption.
 - e) Associated alarms.

- O. Approval:
 - 1. System (heating cable, connection kits, and controller) to be UL-listed, CSA-certified for surface snow melting of concrete and asphalt, and under pavers.
 - 2. Snow-melting system has design, installation, and operating manual specific to surface snow melting.

2.3 SYSTEM APPROVAL

- A. Complete system (heating cable, connection kits, and controller/thermostat) to be listed by a nationally recognized testing laboratory (NRTL).

PART 3 - EXECUTION

3.1 SURFACE SNOW MELTING

Retain this article for RAYCHEM's "MI System" applications.

- A. Examination:
 - 1. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - a. Ensure that surfaces in contact with electric heating cables are free of burrs and sharp protrusions.
 - b. Ensure that surfaces and substrates are level and plumb.
 - 2. Preinstallation Testing:

- a. Prior to installing heating cable, an insulation resistance test is performed by installing Contractor to ensure integrity of heating cable as described in installation and maintenance manual.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation:

1. Protect all heating cable ends from moisture ingress until cable is terminated with end seals.
2. Protection of In-Place Conditions:
 - a. If there is any delay between installation of heating cables and placement of topping course, take the following precautions to protect the installation:
 - 1) Record post-installation test results immediately.
 - 2) Do not energize cables.
 - 3) Mechanically protect cables so they cannot be damaged by pedestrian or vehicular traffic, paint, welding, falling objects, inclement weather, or other inappropriate exposure.

See RAYCHEM's "[MI System Installation and Operation Manual H47754](#)" for snow melting.

C. Installation, Surface:

1. Cable:
 - a. Install heating cable in accordance with national and local electrical codes, manufacturer's written instructions, and instructions provided with heating cable and components.
 - b. Lay cables such that sheaths do not touch or cross one another. Concrete expansion and/or crack-control joints to be crossed in accordance with specific procedures provided by manufacturer.
 - c. Lay cables at spacing specified in construction documentation.
 - d. For MI cable, spacing must not exceed **10 inches (250 mm)** in concrete or **6 inches (150 mm)** in asphalt, to promote equal heat distribution at the surface.
 - e. Locate junction boxes in accessible areas, above grade (unless indoors). Junction boxes are not located in heated slab. Keep covers on enclosures when not working therein.
 - f. Protect terminations from weather and from mechanical damage. Gland assembly is bonded to system ground. When fishing cable cold leads through conduit, cold lead tails are not pulled.
 - g. Field alterations or deviations to proceed only after authorization issued by Project engineering team. All changes are accurately recorded by Contractor and provided to engineer at completion of that phase of work.
 - h. After laying heating cable, perform same tests as outlined in manufacturer's installation manual, and record results in same Results table. Continuity test reading should be the same; Insulation Resistance test reading should exceed 1,000 M Ω . Notify construction team of unsatisfactory test results and stop work in that area until issue is rectified. Cable manufacturer is capable of assisting with troubleshooting.

D. Installation, Embedded:

1. Do not energize cables embedded in concrete or asphalt until those assemblies are cured.
2. All heat tracing components including power connections, splices, tees, crosses, or end seal, must be installed above grade and protected from abuse or damage. By NEC and CEC, electrical connections are not permitted to be installed below grade.

3. Install heating cable with heat-conductive fill materials such as asphalt or concrete to ensure direct contact with finished radiant surfaces.

Retain first subparagraph below for asphalt paving.

4. Install cables after applying bituminous binder course to lower base; ensure that second bituminous binder course is applied to cables or mats before pouring finish topping.

Retain first subparagraph below to require a flush-mounted box to identify embedded heating array. Coordinate with paving Sections.

5. Install embedded electric heating-cable or identification box where indicated in pavement before pavement work is completed.

Retain subparagraph below for cast-in-place concrete paving and to require embedded heating array to be identified by stamping.

6. Stamp concrete with embedded electric heating-cable identification in accordance with NFPA 70 and complying with requirements in Section 033000 "Cast-in-Place Concrete."

E. Sensors and Controllers

1. General:
 - a. Mount sensors in upright position in an area clear of overhead trees, wires, eaves, and similar, and not at risk from falling debris. Avoid exposure to artificial heat-sources and shock vibration.
 - b. Select location representative of anticipated precipitation conditions in area(s) where snow-melting system is installed.

Consider pavement-mounted sensor for snow melting on pavement.

- c. Mount precipitation sensor in pavement.
- d. Provide power for sensor in accordance with electrical codes and standards.
2. Slab temperature sensor for the following:

Retain "Group Control and Power Distribution Panel" or "Distributed Control Network" Subparagraph below.

- a. Group Control and Power Distribution Panel:
 - 1) Install metallic conduit, **3/4 inch- (19-mm-)** minimum diameter, for accommodation of the slab thermistor between runs of heating cable prior to topping course pour. Conduit shall not cross runs of heating cable, and to end no less than **18 inches (450 mm)** within heated section of slab. Seal conduit at its extent to prevent ingress of paving material during pour and moisture after.
 - 2) After topping course is complete, insert slab temperature sensor to end of previously installed conduit. Use fish tape (or similar) to push thermistor in, and abandon in-place, for the dual purpose of ensuring it gets to end and allowing future removal.
- b. Distributed Control Network:
 - 1) Install metallic conduit, **3/4 inch- (19-mm-)** minimum diameter, for accommodation of the slab-sensing RTD between runs of heating cable

prior to topping course pour. Conduit to not cross runs of heating cable, and to end no less than **18 inches (450 mm)** within heated section of slab. Seal conduit at its extent to prevent ingress of paving material during pour and moisture after.

- 2) After topping course is complete, insert slab temperature sensor (RTD) to end of previously installed conduit. Use fish tape (or similar) to push thermistor in, and abandon in-place, for the dual purpose of ensuring it gets to end and allowing future retrieval without undue tension on sensor assembly itself.

Indicate location of controls on Drawings.

3. Energy-Efficient Control System:
 - a. Group Control and Power Distribution Panel:
 - 1) Mount panel in accordance with manufacturer's installation and operating manuals and applicable codes and standards.
 - 2) Power and control wiring is made safe prior to energizing panel.
 - b. Distributed Control Network:
 - 1) Mount panels in accordance with manufacturer's installation and operating manuals, and applicable codes and standards.
 - 2) Set control module addresses prior to energizing system. Avoid duplication of addresses.
 - 3) Power and control wiring is made safe prior to energizing panel. Energize circuits in order specified in installation and operating manuals to ensure network connectivity.

F. Connections:

1. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
2. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

G. Field Quality Control:

RAYCHEM offers initial start-up and field testing (commissioning) of the system as a service. For information, contact local representative, visit www.nvent.com/RAYCHEM or contact RAYCHEM Technical Support at (800) 545-6258.

1. Manufacturer's Field Service: Initial start-up and field testing (commissioning) of system is performed by factory technician in accordance with Owner's requirements.
2. Contractor to perform the following tests and inspections during installation:
 - a. Heating cable is meggered when received at Project site before installation.
 - b. Heating cable is meggered after installation, but before insulation is installed.
 - c. Heating cable is meggered after insulation is installed.
 - 1) Insulation resistance must exceed 1000 megohms at 2500 V dc.
 - d. All results must meet manufacturer's specification.
 - e. Megger test cables for electrical insulation integrity throughout installation.
 - 1) Be prepared to halt installation of topping material if a break in the insulation integrity is identified.
 - 2) Block out areas of damaged cable for later repair. Leave **18 inches (457 mm)** exposed on either side of cable to make splice repair.

- 3) Resume pour once area for splice is in place.
- f. Test insulation integrity before energizing.
- g. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
- h. Repeat tests for continuity, insulation resistance, and input power after applying finished surface on heating cables.

See Section 014000 "Quality Requirements" for retesting and reinspection requirements and Section 017300 "Execution" for requirements for correcting the Work.

3. Electric heating cables will be considered defective if they do not pass tests and inspections in accordance with manufacturer's requirements.
4. Technician to verify that the controller parameters are set to the application requirements.
5. Technician to verify that RAYCHEM's "ACS-30" and "ProtoNode" device server (if applicable) are configured correctly with the BMS.
6. Provide factory-certified technician or manufacturer's representative for a start-up and commissioning of heat tracing system and controller.
7. Prepare test and inspection reports.

H. Protection:

1. Protect installed heating cables, including nonheating leads, from damage and moisture ingress during construction.
2. Remove and replace damaged electric heating cables.
3. Comply with manufacturer's written instructions for maintenance service.

END OF SECTION 238313